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A few modest remarks on *Statistical Mechanics made simple: A guide for students and researchers*, by Daniel C. Mattis (World Scientific 2003)

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There are many books on *Statistical Mechanics* (or *Statistical Physics*), but this one is unique: Professor Mattis succeeded to give an extremely clear, very concise, and proper in the highest degree, account of what is usually called *Statistical Mechanics*. The exposition is, not in the least, charming, which makes enchanting reading. Professor Mattis writes on difficult subjects in physics with the ease of the great masters of science. I must confess that I myself, often, after prolonged time in dealing with research in physics and teaching physics, still go for Mattis' texts to look for assurance, enlightment and confidence. I highly recommend this *Guide* to everyone interested in the subject, and am convinced that it will soon become an indispensable world wide textbook.

As regards Statistics in Physics I myself would prefer *Statistical Physics* for its name, because *Statistical Mechanics* sounds to me too much as if one would like to derive Statistics from Mechanics. However, Professor Mattis gives in this book such a beautiful description of the intricate mechanisms and machineries of the *Statistical Physics*, with such an amazing and convincing accuracy, going with such a mastership through fluctuations, dissipation, noise and signals, that the old *Statistical Mechanics* gets this way a new, much more proper, legitimacy.

It seems that Professor Mattis exploits extensively, in the manner of presenting the material in this book, the expertise he gained many years ago when succeeded to give a highly acclaimed field-theoretical account of the famous Onsager's solution to the two-dimensional Ising model, in the celebrated, and very influential, paper of Schultz, Mattis and Lieb, in Revs. Mod. Phys. **36** 856 (1964). The mathematical methods and tricks of the *Statistical Physics* are not often very easy to handle, but Professor Mattis render them so manageable that, after reading his book, everyone feels encouraged to tackle even the most resistent issues in *Statistical Mechanics*, like, for instance, the three dimensional Ising model. This is a great merit of this book, that of re-examining our hopes. I must confess again to having always been uncomfortable at not having an exact solution for the three dimensional Ising model, for instance, and learnt to get satisfied with an approximation to the critical point only reluctantly, after a long time. Reading now the Chapter 8 in Professsor Mattis' book on the transfer matrix, I admit to have been tantalized again into re-examining this old issue. Such texts make an excellent basis of discourse between a teacher and his students, and feed a live enthusiasm for our science. In this respect, I only wished Professor Mattis to explain for us in this Chapter 8 Kramers' argument of duality for the Ising critical point too. I expect such an explanation, coming from Professor Mattis, to be an exquisitely delightful piece of physics.

The book starts with an Introduction that explains what Thermodynamics, Kinetic Theory and Statistical Mechanics would be. (Here, on p. xiv, top 2-3 lines a typo error doubles a "whenever".) Then, the introduction describes the Table of Contents, which comprises the basics of Thermodynamics and Statistical Mechanics, Magnetism and the Non-Ideal Gas, Bosons and Fermions, Kinetic Theory and Transfer Matrix, and some field-theoretical techniques in *Statistical Physics*.

An introductory chapter of the book introduces the binomial, Poisson and Gauss distributions of probability, the Brownian motion and the random walk, the central limit theorem and attempts to connect them with the principles of the *Statistical Mechanics*. The flavour of the wonderful machinery of the *Statistical Physics* is all captured in this chapter. Another typo error makes here, on p.2, the bottom 9th line, a "p" instead of "p_1".

The next chapter starts enchantingly by trying to motivate a unique theory for magnetism and fluids: the Ising model. Here, the free energy, entropy and temperature are introduced, together with the great principle of thermodynamics, the maximum probability. Then, Weiss' mean-field is described, and applied to ferromagnetism. The role of dimensions is also convincingly demonstrated here, by means of the Ising model in one dimension, where there is no phase transition. The history of the Ising model is briefly sketched here, and the main motivation for this classical subject of *Statistical Mechanics* is reiterated already in this beginning chapter. Heisenberg's chain that ends this chapter may suffer a little perhaps of another typo which fails to bold, or arrow, the spin vectors.

The next chapter introduces the thermodynamic potentials, the laws of thermodynamics, equation of state, wan der Waals equation, phase transitions, Clausius-Clapeyron equation, the Carnot cycle, and contains a few other very interesting remarks about the generality of the thermodynamics, as, for instance, applied to superconductors. All this chapter is extremely useful, the discussion being simple, accurate, natural - worth noting, considering that thermodynamics is usually held to be such an abstract topic.

The machinery of the *Statistical Mechanics* is introduced in the next chapter with great mastery. Gibbs factor and the partition function for the ideal gas are presented, real gases and the virial equation of state follow, Takahashi gas in one dimension, structure factor and long-range order, again the absence of long-range order in one dimension and Landau's famous connection of the long-range order with the phase transitions.

The next two chapters are devoted to bosons and fermions. Bosons are introduced via the harmonic oscillator, and the wave function symmetry discovered. In contrast, antisymmetry is reserved to fermions. The great connection of spin with statistics is indeed not relevant for statistical machinery. Photons and black-body radiation are presented here, phonons as well, and the ferromagnons, and of course, the Bose-Einstein condensation, the dimensionality effects on it, the one-dimensional boson-fermion equivalence, and the relevance of Bose-Einstein condensation for superfluidity. With respect to the later, Bogoljubov's and Feynman's theories are briefly sketched. Regretfully, Landau's theory is omitted. An interesting subject in the same vein would have been here the recent boson-fermion equivalence in two dimensions that was pointed out by M. Howard Lee (in Phys. Rev. **E55** 1518 (1997); see also ibid, **E56** 4858 (1997)).

Fermi-Dirac statistics are presented with great clarity, without saying much about the electron interaction in real metals. Then, the statistics of the semiconducting charge carriers is analyzed, and a sketchy, but highly illuminating account of the basics of the superconductivity is given. Very balanced remarks are included here on high-temperature superconductivity. Here I could only remark that John Bardeen was not the only one to get two Nobel prizes, he joined Marie Curie, who got also a second, true, in chemistry not in physics. Pauling followed with one in physics, and a second for peace.

Kinetic theory, transport theory, propagation, attenuation, dissipation and difussion are discussed in a distinct chapter, by introducing the collision integral, transition probability and the principle of detailed balance. The celebrated Boltzmann's H-theorem is then presented, as well as the master equation, approach to equilibrium, diffusion, electric conductivity, Hall effect, dealing, generally, with collison integrals. Condensed matter, as made up of quantal mechanics and statistical physics, reaches its apogee with these topics, which usually form what is called the *Physical Kinetics*.

Diffusion, one of the key cores of *Statistical Physics* after Einstein, is presented in the final chapter by Doi's theory. This chapter includes also the Mermin-Wagner theorem on the absence of long-range order in low dimensions, and an introduction to thermodynamic Green's functions, with a special application to random glassses.

The *Statistical Mechanics* of Professor Mattis looks like a great intellectual achievement of our epoch. It is a masterpiece of a profound thinker in physics and a master of technical virtuosity in this science This book should mould the forthcoming generations of our students, because the *Statistical Physics* in the new century will undoubtedly follow the lines drawn by Professor Mattis in this great book.